#B

Delay Actuator,
Silicone

27 January 1958

MEMORANDUM FOR: Office of Logistics/Procurement Division/Contract Branch

SUBJECT : Request for Extension of Time and Additional Funds for Task J under Contract RD-26 with [redacted]

1. It is requested that arrangements be made to provide additional time and funds for Task J under Contract RD-26 with [redacted]

2. The purpose of this task is for continued research and development of a time delay firing device based on the metered flow of a high-viscosity fluid through a variable orifice. Refinements in the existing design will be made in an attempt to provide the unit with automatic temperature compensation over the range of -20°F to +120°F. Laboratory models will be constructed for evaluation testing.

3. The total additional cost for this development has been estimated at $10,600, including the fixed fee, for a seven month extension of research. This cost is considered reasonable.

In the estimation of the project engineer, this work comes within the scope of the original program initiated with [redacted] in fiscal year 1957 as Task J under Contract RD-26. Charges should therefore be made against Allotment Number 7-2502-10.

4. Further technical information concerning this program may be obtained from the project engineers, [redacted], [redacted] extension [redacted].

[redacted]

28 Jan

[redacted]

Attachments:
Contr'r Proposal Dtd 17 Jan 58
TSS-313-P7-1435-57

APPROVED FOR THE OBLIGATION OF FUNDS:

[redacted]

[redacted]

Distribution:
Orig & 1 - Addressee
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1 - RD-183E
1 - BM File

Delay Actuator, Silicone

In replying please address:

25X1

January 17, 1958

Dear Sir:

Enclosed is a proposed research program directed toward the further development of a silicone-fluid, time-delay mechanism which was evolved under Task Order No. J. The proposed research program is based on recent discussions with your technical representative.

In the course of the previous research under Task Order No. J, we evaluated the flow characteristics of a silicone fluid which had been selected as the timing medium. Pertinent basic information on the flow of this fluid was obtained, a practical design of a time-delay mechanism was outlined, and successful experiments were conducted on important components of the design. At this stage, it is proposed that additional research be performed that would be directed toward establishing the accuracy of the temperature-compensating component and developing an experimental working model of the time-delay device. We feel confident that the results of the proposed research will be favorable and that a working model of a satisfactory silicone-fluid, time-delay mechanism can be developed.

SECRET

 January 17, 1958

If you should have any questions regarding our proposed research program, please let us know. Any inquiries of a contractual nature may be directed to [redacted] at Extension 159. 25X1

Very truly yours,

[redacted] 25X1

Vice President

EES:tr

Enclosure

In Duplicate

SECRET

PROPOSED RESEARCH PROGRAM

ON

THE FURTHER DEVELOPMENT OF A SILICONE-FLUID, TIME-DELAY MECHANISM

Introduction

During the past several years, a search by many organizations for a cheap, reliable, and reasonably accurate time-delay mechanism has led to the consideration of silicone fluid as a timing medium. Under Task Order No. J, basic design criteria were established for an experimental unit of this type that used a silicone fluid. As currently envisioned, in such a unit a spring-loaded piston would force the fluid through an orifice and would advance until a spring-loaded firing pin was released. The release or delay time would be established primarily by the size of the orifice and by the magnitude of the spring force acting on the piston. In such a unit, the time delay period would be affected by changes in the viscosity of the fluid, and hence by changes in the flow of the fluid, as a result of variations in ambient temperature. We believe that a satisfactory temperature-compensator design has been demonstrated experimentally under Task Order No. J; this, combined with the design of other components that we have developed experimentally, constitutes a potentially successful time-delay mechanism. However, the ultimate success of such a mechanism would depend upon the proper selection of materials and dimensions for the temperature compensator to be used in combination with appropriately sized springs for actuation of the piston.

Such a temperature compensator, as currently visualized, would contain two orifices: one would be a simple circular-cross-sectioned port and the other would be a temperature-compensating orifice formed by the annular space between two components made from selected materials having different coefficients of thermal expansion. Variations in temperature would affect the size of the annular orifice and thus the flow through it. With an increase in temperature, the viscosity of the fluid would decrease and consequently the flow rate through the simple circular-cross-sectioned port would increase. The flow rate through the annular orifice, however, would decrease with increasing temperature if the materials for the orifice-forming parts were selected so that the orifice size would be reduced rapidly with an increase in temperature. The total flow rate of a silicone fluid, for instance, Viscasil 500,000, through a circular and an annular orifice has been shown, by calculation, to be within ±5 per cent of the ideal value for a temperature range from -20 to +120 F.

In our previous experiments with an experimental temperature-compensating unit, the compensation obtained was not perfect; the calculated variation in the flow rate was approximately ±12 per cent from a mean value. Hence, the calculated total variation for a time-delay mechanism with such a compensator would be approximately ±15 per cent. However, since this value was obtained on the basis of sizes and materials for the components that did not necessarily constitute an optimum combination, it is expected that this variation could be reduced below the required ±10 per cent by a more knowledgeable selection of these parameters.

Discussion of the Problem

At the present time, as a result of the effort under Task Order No. J, we believe that the basic design of a satisfactory experimental silicone-fluid, time-delay mechanism has been established and that the major components of this design have been proven experimentally.

Two aspects of the problem remain to be investigated before a prototype device can be prepared. Combinations of sizes and materials for the components of the temperature-compensating device have to be selected and evaluated under laboratory conditions, and an experimental model of the entire time-delay mechanism has to be prepared and evaluated.

The following requirements represent goals toward which we would direct the effort proposed on the development of an experimental model:

(1) It should have a high degree of reliability.

(2) It should be accurate to within ±10 per cent of the time setting.

(3) It should retain its accuracy over a temperature range of -20 to +120 F.

(4) It should have an adjustable time range from 15 minutes to 2 months.

(5) It should not weight more than 1/2 pound.

(6) It should not be larger than about 1 inch in diameter and about 4 inches in length.

Objective

The objective of the proposed program would be to conduct research directed toward the further development of the above-described silicone-fluid, time-delay device in an effort to satisfy the requirements outlined above. If, as expected, the results of the proposed program were favorable, research would be directed toward preparing and evaluating an experimental model of the device.

General Procedure

Since the basic design for a suitable experimental time-delay device has been established, we would calculate, with the aid of IBM computers, the sizes of temperature-compensator components of various materials that would minimize the variation in the flow rate; the choice of the materials included in this study would be based on coefficient of thermal expansion characteristics. After this information was compiled and studied, combinations of sizes of components and associated materials that appeared to be conducive to a minimal variation in flow rate would be selected and laboratory temperature-compensating units, based on those combinations, would be prepared and evaluated.

We currently expect that, at the most, eight different materials would be evaluated. However, the calculations may indicate the feasibility of evaluating fewer materials and only minor size modifications, and consequently the number of experiments might be reduced. The experiments contemplated would be of short duration and would be conducted at temperatures of -20, 50, and 120 F; they would be directed toward evaluating the effectiveness of each combination used for the temperature-compensating (annular) orifice in controlling the flow rate. It is expected that only minor modifications of the laboratory units used in these experiments would be required at that stage in order to provide an effective experimental temperature compensator.

If, as expected, the results of the above-described research were favorable, a laboratory model of a time-delay unit incorporating the previously evolved experimental temperature compensator would be designed and prepared. The primary aim at that stage would be to investigate the accuracy that could be achieved in machining the selected materials and in preparing the parts. This problem of machining accuracy would pertain to the laboratory units used in the above-described temperature-compensation experiments as well as to the laboratory model of the time-delay device, but would be more critical in regard to the latter.

Subsequently, within the time and funds, a few additional units of the laboratory model of the over-all device would be prepared, and the performance of all of these models would be evaluated in a few short-duration experiments at each of the three previously mentioned temperatures. Then a few similar but longer duration (approximately two months) experiments would be conducted using these models. Also at that stage, the research would be directed toward the preparation and subsequent evaluation of an operable experimental model of the time-delay device. It is expected that any modification of the experimental model that might be necessary would be minor, primarily because of the prior development and evaluation of the critical components.

The experimental model of the time-delay device would then be transmitted to the Sponsor for further evaluation.

Reports

Monthly letter reports would be prepared to keep the Sponsor informed of the progress of the research. These would be supplemented by meetings with the Sponsor. At the conclusion of the proposed research period, a summary report would be prepared.

Duration and Estimated Costs

It is proposed that the contract provide for a seven-month period of research, with an estimated appropriation of $10,600, including the fixed fee. The general breakdown of estimated costs is attached.

The Contract

The proposed contract would be a period-basis research agreement, consistent with our current contractual arrangements and providing only for a fixed period of research leading toward the objective outlined in this proposal.

Proposal of [redacted] to **the U. S. Government.** 25X1

For Research on **The Further Development of a Silicone-Fluid, Time-Delay Mechanism.**

Based upon a period-basis Contract for a research period of **seven months.**

(Including time for submission of all reports. The proposed contract will not provide for earlier conclusion of the research.)

ESTIMATED COSTS

We expect that the cost of this research for the period indicated above may be distributed approximately as set forth hereon, subject to the understanding that this allocation is merely an estimate, and actual costs incurred may vary from the categories shown. We have determined that these estimates are reasonable and consistent with [redacted]s established policies in its research for the various Government agencies, which policies are briefly discussed below and will be followed in determination of our actual costs hereunder. 25X1

Materials & Supplies, etc. $500

(Including any equipment which may be purchased as necessary in performance of the research. Charges of $25 or less are excluded from this item.)

Use of Equipment and Technical Services, Travel, and Misc. $1,300

(Including applicable costs of technical research and service divisions, and use of technical equipment, except that any undistributed balances of these accounts will be included in overhead. Cost of travel includes reasonable actual subsistence expenses and the actual cost of transportation. An allowance of up to 8¢ per mile for all necessary travel by privately owned conveyance is included in lieu of the cost of such travel.)

Salaries & Wages

(Including our predetermined accrual for vacation, holiday, and sick-leave pay, pensions, and social security.)

Type of Employee	*No. of Man-Months*	*Estimated Cost*	
Supervision	1/2	$500	
Research Engineers	4	2,800	
Lab. Assistants	4	1,640	
Steno., Clerical, Shop & Photo., etc.	1	315	
Total Salaries & Wages			$5,255

Overhead

(56 per cent of salaries and wages, as they are defined above. Provisional monthly reimbursement will be at the rate of 52 per cent of salaries and wages, as so defined, or at such other provisional rate as may from time to time be mutually agreed upon with the Government's audit representatives. This is a provisional rate for current reimbursement, which we have arrived at by negotiation with Government representatives, and it will be subject to retroactive revision to the "actual" rate agreed upon with them for each calendar year following a detailed audit for that year. The item of overhead includes general research, charges of $25 or less for materials and supplies, and other categories of costs we customarily include in our overhead account. Cash discounts on all purchases will be credited to overhead, instead of to the amount of the purchase. Scrap of appreciable value will be credited directly to the project. All other scrap will be credited to the overhead account, in which the Government participates.) $2,945

Total Estimated Cost	$10,000
Fixed Fee	600
Contract Price	$10,600

*Please let us have your acceptance in our hands by **February 28, 1958.**

Unless we extend the time, your acceptance after that date will be subject to agreement.

[redacted] E 25X1

10/57

#118 - Delay Actuator, Silicone Delay [redacted]

[redacted] 25X1 25X1

October 11, 1957

Dear Sir:

This letter report describes the progress of Task Order No. J from September 8 to October 8, 1957.

Previous experiments had shown that the original design of the temperature compensator did not perform so satisfactorily as had been expected. Accordingly, during this period, we concentrated our effort on the design of a better compensator. Two types were devised. The error in timing was calculated for both of these designs and it appears that one of them might be feasible.

In our letter report dated September 20, 1957, we mentioned a design for a temperature compensator which would have no moving parts. The unit would have two orifices; one would be a temperature-compensating orifice formed by the annular space between two concentric cylinders of different materials, steel and plastic; and the other would be a simple circular port. We calculated the total flow, which would be the combined flow through both of these orifices, over the pertinent temperature range -20 to +120 F. The variation from a mean design value would be only ± 4.4 per cent. However, there would be one serious drawback; the ratio of the average pressures exerted on the fluid by the springs corresponding to the shortest and to the longest time periods would be approximately 6,000 to 1. Previously, we did not conceive of any satisfactory way of

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changing the pressure in line with this ratio. In the new system being considered, there is a certain amount of flexibility. This pressure ratio could be affected by changing the length of the annular orifice and by changing the materials used for the compensator; in the final design, an assembly, which would cover a particular time range, would be inserted into the main body just before the device was used. It appears that this device might be feasible under this condition.

In the second design, the compensator would change the port area which restricts the flow as the temperature increases. For the initial calculations, we selected a triangular orifice with one movable side made of neoprene. The force which would move the neoprene would be developed by the expansion and contraction of a predetermined volume of mercury. Because the mathematics for this system is rather complex, we estimated the accuracy of this device. It is expected that the timing would vary by about ± 10 per cent of a mean design value over the temperature range -20 to +120 F; this is considered excessive.

During October, we plan to select the materials and sizes of the parts for the first design described. If time permits, an experimental unit will be built to verify the assumptions made.

The original appropriation on this Task Order was $18,550. As of October 1, 1957, the unexpended balance was approximately $3,800.

Sincerely,

25X1

ABW/ba

In Duplicate